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09/820,079	03/28/2001	Grant Kloster	42390P11026	4031

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EXAMINER

MAGEE, THOMAS J

ART UNIT	PAPER NUMBER
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2811

DATE MAILED: 08/28/2003

20

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

09/820,079

Applicant(s)

KLOSTER ET AL.

Examiner

Thomas J. Magee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 11 July 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1,3-10,12-14 and 16-20 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1,3-10,12-14 and 16-20 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

## Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_.
- 4) ☐ Interview Summary (PTO-413) Paper No(s) \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

## **DETAILED ACTION**

### ***Claim Cancellations***

1. Applicant's cancellation of Claims 2 and 11 in Letter No. 19 of July 25, 2003 is acknowledged.

### ***Claim Rejections – 35 U.S.C. 103***

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office Action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1 and 5 – 8 are rejected under 35 U.S.C. 103(b) as being unpatentable over Chen et al. (US 6,211,061 B1) in view of Fink et al. ("Standard Handbook for Electrical Engr." McGraw-Hill, New York (1968)).

4. Regarding Claim 1, Chen et al. disclose (Col. 5, line 65 through Col. 6, line 22) a structure on a substrate comprising a diffusion barrier layer (24) (Figures 4 and 6B) having a first dielectric constant (7.5, silicon nitride), and a thickness in the range, 300 to 500 Angstroms, with an etch stop layer above and on the diffusion barrier layer with a second thickness in the range, 1600 to 7000 Angstroms and a dielectric constant < 3.0 and an interlayer dielectric of thickness, 1000 to 3000 Angstroms, with a dielectric constant of 3.9 (silicon

dioxide).

Chen et al. do not disclose the effective dielectric constant of the structure. However, the determination of effective dielectric constant is calculable from extremely simple equations notoriously well known to those of average skill in the art using elementary Physics and Electrical Engineering texts and handbooks (See for example, "Standard Handbook for Electrical Engr."). Capacitance for capacitors in series (stack of dielectric layers) is:  $1/C(\text{total}) = 1/C(1) + 1/C(2) + \dots$ . And in general,  $C = kA/d$ , where  $k$  is the dielectric constant,  $A$  is area, and  $d$  is thickness. The effective dielectric constant is then approximated by:  $d(\text{total}) / [(d1/k1) + (d2/k2) + (d3/k3)]$ , where  $d1, k1, \dots$  refer to layer 1, etc. Substituting values disclosed by Chen et al. in the equation, the effective dielectric constant is less than three, and is therefore, an inherent property of the structure.

5. Regarding Claims 5 and 6, Chen et al. disclose (Col. 6, lines 4 – 12) that the barrier layer is inorganic (silicon nitride) and the etch stop layer is organic (FLARE, SILK).

6. Regarding Claim 7, Chen et al. disclose that an electrically conductive trace is present in the substrate (Col. 5, lines 65 – 67) (20, Figure 6B) and a contact (Col. 8, lines 1 – 2) present in a recess (45) that extends through the ILD, etch stop, and barrier layers making electrical connection to the trace.

7. Regarding Claim 8, Chen et al. do not disclose a "single" damascene structure for the contact, but do disclose a dual (or T-shaped) damascene structure. The difference between a single and a dual damascene structure involves only a change in shape and a contin-

uous etch through the layers for the single, whereas the dual requires two etch steps. Hence, it would have been obvious to one of ordinary skill in the art at the time of the invention to alter the "shape" of the contact to produce a single damascene structure. Consistent with rulings of the court, changes in size or shape of parts of an invention, in the absence of an unexpected result, involve only routine skill in the art. In re Dailey, 357 F.2d 669, 149 USPQ 47 (CCPA 1966).

8. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. in view of Fink et al., as applied to Claims 1, and 5 – 8, and further in view of Wang et al. (US 6,291,887 B1) and Wolf ("Silicon Processing for the VLSI Era, Vol. 4 – Deep Sub-micron Process Technology," Lattice Press, Sunset Beach, CA (2002), p. 641) and Gabriel et al. (US 6,448,654 B1).

Chen et al. do not disclose an organic diffusion barrier layer and an inorganic etch stop layer. However, Wang et al. disclose (Col.8, lines 16 – 21, lines 44 – 46) that the first (diffusion barrier) layer is a polymer (organic) and the etch stop layer is nitride (inorganic). Wang et al. disclose a thickness for the etch stop layer of 4000 to 8000 Angstroms. Scaling in Figure 11, discloses a thickness  $\ll 1000$  Angstroms for the diffusion barrier layer, consistent with Chen et al. and recitations of the instant application. Further, Gabriel et al. disclose (Col. 4, lines 36 – 52) that thin (500 Angstroms) dielectric layers at the surface are desirable to provide versatility in the selection of more etch resistant materials for layers. Using the calculation for effective dielectric constant discussed earlier, it is then possible to obtain an effective dielectric constant  $< 3$ , using a choice of low k materials (See Wolf, Figure 14-

2). Hence, it would be obvious to one of ordinary skill in the art at the time of the invention to combine Wang et al., Wolf, and Gabriel et al. with Chen et al. and Fink et al. to provide a structure containing low k layers that would avoid undercutting (Wang et al., Col. 4, lines 58 – 62) of the first dielectric layer during etching to form damascene contacts.

### ***Claim Rejections – 35 U.S.C. 102***

9. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) and the Intellectual Property and High Technology Technical Amendments Act of 2002 do not apply when the reference is a U.S. patent resulting directly or indirectly from an international application filed before November 29, 2000. Therefore, the prior art date of the reference is determined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

10. Claims 9, 10, and 16 - 18 are rejected under 35 U.S.C. 102(e) as being anticipated by Chen et al.

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11. Regarding Claims 9 and 10, Chen et al. disclose (Col. 5, line 65 through Col. 6, line 22) a conductive trace (20) in a substrate and coplanar with the upper surface, with a structure on the substrate comprising a inorganic (silicon nitride) diffusion barrier layer (24) (Figures 4 and 6B) above and on substrate and trace, having a dielectric constant (7.5) and a thickness in the range, 300 to 500 Angstroms, with an organic etch stop layer above and on the diffusion barrier layer with a thickness in the range, 1600 to 7000 Angstroms and a dielectric constant  $< 3.0$  and an interlayer dielectric of thickness, 1000 to 3000 Angstroms, with a dielectric constant of 3.9 (silicon dioxide).

12. Regarding Claims 16 – 18, Chen et al. disclose (Col. 5, line 65 through Col. 6, line 22) a structure on the substrate comprising an inorganic (silicon nitride) first dielectric layer (24) (Figures 4 and 6B) above and on substrate and trace, having a dielectric constant (7.5) and a thickness in the range, 300 to 500 Angstroms, with an organic (polymer) second dielectric layer above and on the diffusion barrier layer with a thickness in the range, 1600 to 7000 Angstroms and a dielectric constant  $< 3.0$  and an interlayer dielectric of thickness, 1000 to 3000 Angstroms, with a dielectric constant of 3.9 (silicon dioxide), wherein, a conductive damascene "plug" is present (Col. 8, lines 1 and 2) in recess 45 (Figure 6B), where the conductive layer is in contact with first dielectric layer, second dielectric layer, and ILD layer.

***Claim Rejections – 35 U.S.C. 103***

13. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obvious-

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ness rejections set forth in this Office Action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

14. Claims 12 – 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al., as applied to Claims 9 and 10 above; and further in view of Fink et al. and Wolf.

Chen et al. do not disclose effective dielectric constants for the ILD, etch stop, and diffusion barrier layer “stacks”. As discussed for Claim 1, the effective dielectric constant is approximated (Fink et al.) by the equation:  $d(\text{total}) / [(d1/k1) + (d2/k2) + (d3/k3)]$ , where  $d1, k1, \dots$  refer to thickness and dielectric constant of layer1, etc. Using the values of thickness over the range disclosed by Chen et al. and dielectric constants of low k materials (Wolf), the approximate range of effective dielectric constants is calculated from 2.5 to 3.

Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention to Fink et al. and Wolf with Chen et al. to obtain low effective k values for the “stack” combination.

15. Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. as applied to Claims 16 –18 above, and further in view of Wolf.

Chen et al. do not explicitly disclose a dielectric constant for the second dielectric layer. Wolf (Figure 14-2) discloses that SILK (one of second dielectric materials disclosed by Chen et al.) has a dielectric constant less than about 2.8.

16. Claim 20 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al. as applied to Claims 16 – 18 above, and further in view of Bains (“Nanostructured



Dielectrics Good Candidates for Next Generation Computer Chips," OE Reports, No. 194, (February, 2000) pp. 1 – 3).

Chen et al. do not explicitly disclose that the second (organic) dielectric layer has a dielectric constant of about 2. However, Bains discloses that IBM produces a porous organosilicate dielectric material of dielectric constant equal to 2.2. Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to utilize an organosilicate material with pores to attain a low k second dielectric layer for use in forming damascene interconnects, and hence to combine Bains and Chen et al.

### ***Response to Arguments***

17. Applicant's arguments with respect to claims have been considered but are moot in view of the new ground(s) of rejection. However, it should be noted that Applicant's contention that barrier (not isolation) layers, as disclosed in the references, are thick (typically 5000 Angstroms) is fallacious. To the contrary, these layers are typically thin (< 1000 Angstroms) (See above references).

### ***Conclusions***

18. Any inquiry concerning this communication or earlier communications from the Examiner should be directed to **Thomas Magee**, whose telephone number is **(703) 305 5396**. The Examiner can normally be reached on Monday through Friday from 8:30AM

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to 5:00PM (EST). If attempts to reach the Examiner by telephone are unsuccessful, the examiner's supervisor, **Tom Thomas**, can be reached on **(703) 308-2772**.. The fax number for the organization where this application or proceeding is assigned is **(703) 308-7722**.

*Tom Thomas*  
TOM THOMAS  
SUPERVISORY PATENT EXAMINER  
TECHNOLOGY CENTER 2800

Thomas Magee  
August 14, 2003